Economic Transformations

Economic Transformations: General Purpose Technologies and Long-Term Economic Growth. By Richard G. Lipsey, Kenneth I. Carlaw, and Clifford T. Bekar. Oxford: Oxford University Press, 2005. Pp. xxi, 595. $45.00, paper.

Richard G. Lipsey is one of the most distinguished general-purpose economists of his generation. This reviewer used his introductory textbook as an undergraduate, and in graduate school read many of his path-breaking papers in monetary theory, international trade, and industrial organization. Later in life Lipsey seems to have discovered his true love, namely Big-think economic history, and as if to make up for the time spent doing other things, has summarized his thoughts and ideas in a large, ambitious, sprawling book coauthored with two of his former graduate students. With apologies, this review partly subsumes them under the Lipsey name.

The book is hard to summarize because it is unusually rich and diverse. It contains long discussions of technological change, its nature, sources, and consequences. Lipsey maintains that technology is at the heart of modern economic growth and asks—once again—what the sources of Western success are. Among other things, the book also treats at length the economics of technological change, the history of science, and population dynamics. It is part grand synthesis, part textbook, part statement of the author's idiosyncratic views, and throughout an excellent read—informed, curious, unafraid of being unconventional or politically incorrect. The book reflects both the unfailing, deep economic intuition and the intellectual curiosity that are the hallmarks of Lipsey's scholarly persona. Dick Lipsey, it might be said, has never met a black box he has not demanded be opened. With his coauthors, he makes a valiant attempt to do so in this book and offers us many brilliant new formulations.

Lipsey joins a large number of economists who, when thinking about the long run, feel that evolutionary models are more appropriate than standard neoclassical ones. No more than anyone before do the authors propose a satisfactory evolutionary model of technological progress that will explain all of history. Instead, they tell a theoretically informed tale that will join the growing literature on the topic of long-term growth, based on a number of interesting, if not wholly new, points of view on modern economic growth.

Arguably, this big volume contains at least two substantive books. One of them is about General Purpose Technologies (GPT), a theme that briefly rose to prominence a decade ago in the literature of the economics of technological change (of which Lipsey was one pioneer). The second is the "Rise of the West" and the beginning of sustained economic growth in Europe in the eighteenth and nineteenth centuries. If there is a connection between the two, however, this book does not stress it. GPTs, it asserts, were not the driving force behind the Industrial Revolution, and the only GPT we can associate with the period 1760–1830, steam power, was a relatively minor factor in the Industrial Revolution. The absence of a direct link between the emergence of GPTs and the book's theories about the rise of the West reduces the coherence of this volume a bit, but does not diminish its *élan*.

Some will argue that GPT is just another name for events and phenomena we have always known about. The term does not, as the authors are the first to admit, consti-

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tute a theory. A GPT is in fact a technique that is complementary with a lot of other techniques. How many is a lot the reader must decide, and the nature of the complementarity is left a bit mysterious. A screw, one would think, is complementary to almost any mechanical construct one can think of, but the screw is not included in their list of GPTs. Ships, on the other hand, are. As the authors argue, ships may seem to have only one use (to move objects from A to B) but they qualify as GPTs, as do automobiles, because they can be used to transport almost anything and are thus complementary to nearly any other technique. The same is true for printing, presumably on the argument that almost any kind of information can be printed. But this seems somehow different from, say, electrical power or microprocessors, which are a direct *input* into the production of many other goods (whereas the printing press only reproduces information). Internal combustion engines do seem rather obvious GPTs, but ships and printing presses only produce one final output, even if that has multiple uses. If the engine and the wheel are GPTs, why not the ball-bearing, the pulley, the lever, etc? The confusion between multiple-use inputs and multiple-use outputs weakens an otherwise tight and informed analysis. At the same time the idea of "factory production," which they classify as an organizational GPT, may seem a bit too vague to qualify for GPT status. Is "factory production" a technique?

The interesting conceptual innovation proposed here is to differentiate GPTs from what the authors call General Purpose Principles (GPPs), which are not embodied in a specific technique. Thermodynamics or Galilean mechanics qualify as such GPPs and they form the basis of much subsequent technological advance, though the connection is not always fully explicated. Here the authors might have found some use for the distinction proposed by this reviewer between prescriptive knowledge (which would include GPTs) and propositional knowledge (GPPs). Furthermore, the authors feel (pp. 189–90) that mechanization should also count as a GPP. This is something on which reasonable people could differ.

Such squabbles are inevitable, and the authors are wise to argue that the definitions are less important than the use to which they are put. At many junctures this reviewer found the categories and terms helpful and enlightening. Thus, the book vastly enriches the concept of macro-inventions by pointing out that there are two kind of "radical" inventions, what they call use-radical and technology-radical. The printing press was use-radical: it relied on principles and ideas that had been around and recombined them to produce an output in a way very different from previous techniques. The minting of coins, for example, was one of its identifiable ancestors. Technology-radical inventions produce a technology that has no obvious parents and is based on entirely new principles and components (such as mechanical clocks, hot-air ballooning, smallpox vaccination, or x-rays). The authors also point out that the importance of a GPT should not be measured just by its contemporaneous effect on productivity. Many of its applications can lie far in the future, and it might be important even without many externalities. The distinction between a positive externality (which is a "free lunch") and a spillover effect (which involves the application of the GPT in another use) is one of the many important insights in this book, and the authors apply it well to their historical case studies. Electrical power is not an "externality" in the sense that its users pay for its use, but it has endless spillover effects, producing huge producer and consumer surpluses by making other techniques possible altogether, which, they maintain, is quite different than the standard treatment of complementarities.

The middle part of the book is devoted the question why the Industrial Revolution and modern growth began in the West and nowhere else. The authors have few doubts

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or qualms about being "teleological," "Whiggish," or "Eurocentric." For them, the difference between the West and the Rest is that Europe created "modern science" and others did not. They dismiss the possibility that China or Islam could have created something similar or perhaps generated economic growth from a very different kind of science. They proceed to describe the rise of Western Science from its medieval roots and explain its absence in other societies. In so doing they rely heavily on the work of Toby Huff and Margaret Jacob, among others, and describe in considerable detail the special circumstances that led to these events. This reviewer differs with the authors on some of the details, but not on the essence of their message: that the Industrial Revolution without the continuing growth of useful knowledge in the West would have fizzled out and become just another efflorescence. Whether this knowledge was "modern science" or something more complex and subtle needs to be hashed out in more detail in future work.

Much of this account will make as much good sense to economists with an interest in economic history as it will annoy and irritate professional historians of science and technology and China experts who refuse to regard China's "case" as one of failure and abhor Western "triumphalism." It would be easy to point to lacunae in the arguments, especially the finer details about the interaction between science and technology in the Industrial Revolution. For the specialist, a sense of puzzlement keeps popping up here and there, especially about the pivotal role the authors attribute to "Newtonian mechanics" in the Industrial Revolution. Institutions matter to growth, in their view, largely because they facilitated the emergence of modern science. Western universities were self-governing semi-autonomous corporations, and the creation of a self-perpetuating but autonomous body of scholars helped create what they call "an institutional memory," which assured that useful knowledge would be cumulative. There is little in this book that connects economic growth to institutional change as it has figured in the modern theory of growth—the rise of commerce, contract enforcement, the role of government, implicit codes of behavior and social norms, and so on. Technology is everything. Perhaps this is just as well: the book is long enough as it is, and others like it, with greater emphasis on institutions, will doubtlessly be written.

After all, whether one agrees with the main points made this book or not, it and books like it fill a need. The questions it poses so well are too important to be left alone as taboo by postmodern social constructivists. If historians of science and technology consider these issues to be politically incorrect, economists will do the work for them. Scholars in the vein of Dick Lipsey, David Landes, and Nathan Rosenberg will continue to ask "Why the West Grew Rich?" and "Why not Elsewhere?" As Robert Lucas once put it, once you have thought a bit about that question, it is hard to think of anything else.

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